

METHOD OF DIAGNOSING, MONITORING, STAGING, IMAGING AND
TREATING GASTROINTESTINAL CANCER

INTRODUCTION

5 This application claims the benefit of priority from U.S. Provisional Application Serial No. 60/188,061, filed March 9, 2000.

FIELD OF THE INVENTION

10 This invention relates, in part, to newly developed assays and compositions for detecting, diagnosing, monitoring, staging, prognosticating, imaging and treating cancers, particularly gastrointestinal cancers including stomach, small intestine and colon cancer.

15 **BACKGROUND OF THE INVENTION**

Cancer of the colon is the second most frequently diagnosed malignancy in the United States, as well as the second most common cause of cancer death. Colon cancer is a 20 highly treatable and often curable disease when localized to the bowel. Surgery is the primary treatment and results in cure in approximately 50% of patients. However, recurrence and metastases following surgery is a major problem and often is the ultimate cause of death.

25 Due to its proximity, cancer of the colon often metastasizes to the small intestine. The prognosis of the cancer spreading to the small intestine is related to the degree of penetration of the tumor through the bowel wall and the presence or absence of nodal involvement. These two 30 characteristics form the basis for all staging systems developed for colon cancer. Various characteristics also assist in prognosticating colon cancer and its spread to the

small intestines. For example, bowel obstruction and bowel perforation are indicators of poor prognosis. Elevated pretreatment serum levels of carcinoembryonic antigen (CEA) and of carbohydrate antigen 19-9 (CA 19-9) also have a negative prognostic significance. However, age greater than 5 70 years at presentation is not a contraindication to standard therapies; acceptable morbidity and mortality, as well as long-term survival, are achieved in this patient population.

Cancer cells can also originate in the small intestine.
10 However, this is a much rarer type of cancer.

Symptoms of cancer of the small intestine typically include pain or cramps in the middle of the abdomen, weight loss without dieting, a lump in the abdomen or blood in the stool.

15 Cancer of the stomach, also referred to as gastric cancer, also frequently metastasizes to the small intestine due to its proximity. This cancer is often difficult to diagnose in early stages and can be in the stomach for a long time, growing to a large size before symptoms arise. In the 20 early stages of cancer of the stomach, an individual may experience indigestion and stomach discomfort, a bloated feeling after eating, mild nausea, loss of appetite or heartburn. In more advanced stages of stomach cancer, there may be blood in the stool, vomiting, weight loss or more 25 severe pain.

Because of the frequency of these types of cancer (approximately 160,000 new cases of colon and rectal cancer per year alone), the identification of high-risk groups, the demonstrated slow growth of primary lesions and the better 30 survival of early-stage lesions, screening for gastrointestinal cancers should be a part of routine care for all adults starting at age 50, especially those with first-degree relatives with colorectal cancer.

Procedures used for detecting, diagnosing, monitoring,
35 staging, and prognosticating cancer of the colon, small

intestine or stomach are of critical importance to the outcome of the patient. Patients diagnosed with early stage cancer generally have a much greater five-year survival rate as compared to the survival rate for patients diagnosed with 5 distant metastasized cancers. New diagnostic methods which are more sensitive and specific for detecting early cancer of the stomach, small intestine and colon are clearly needed.

Patients with gastrointestinal cancers are closely monitored following initial therapy and during adjuvant 10 therapy to determine response to therapy and to detect persistent or recurrent disease of metastasis. There is clearly a need for a cancer marker which is more sensitive and specific in detecting recurrence of these types of cancer.

Another important step in managing gastrointestinal 15 cancers is to determine the stage of the patient's disease. Stage determination has potential prognostic value and provides criteria for designing optimal therapy. Generally, pathological staging of cancer is preferable over clinical staging because the former gives a more accurate prognosis. 20 However, clinical staging would be preferred were it at least as accurate as pathological staging because it does not depend on an invasive procedure to obtain tissue for pathological evaluation. Staging of gastrointestinal cancers would be improved by identifying new markers in cells, tissues, or 25 bodily fluids which could differentiate between different stages of invasion.

Accordingly, there is a great need for more sensitive and accurate methods for the staging of a cancer in a human to determine whether or not such cancer has metastasized and 30 for monitoring the progress of a cancer in a human which has not metastasized for the onset of metastasis.

Thirteen colon specific genes and naturally occurring variants thereof, referred to as CSG1-13, are disclosed in U.S. Patent 5,733,748 and WO 96/39541 for use as diagnostic 35 markers in colon cancer. Some of these genes and polypeptides

encoded thereby are also taught to be useful in determining if the colon cancer has metastasized.

It has now been found that galectin-4 and human carbonic anhydrase I serve as useful markers in the diagnosis of 5 gastrointestinal cancer. These diagnostic markers are referred to herein generally as gastrointestinal specific genes or GSGs and more specifically as Cln114 (galectin-4) and Cln115 (human carbonic anhydrase I).

Cln114 was identified as human galectin-4 of 323 amino 10 acids (translated molecular weight of 35918 Dalton). Galectin-4 belongs to the galectin family that include galectin-1 and galectin-3. Both galectin-3 and galectin-4 are found at high concentrations in intestinal extracts. Galectin-4 contains two beta-galactosidase-binding domains and 15 localizes mainly at sites of cell adhesion. Galectin-4 is a cytosolic protein but like galectin-1 and galectin-3 may be externalized by nonclassical secretory mechanisms and released from the cell. It is possible that galectin-4 is involved in cell adhesion via interaction with extracellular 20 glycoconjugates. Galectin-4 has been suggested to play an important role in the maintenance of epithelial integrity and in the epithelial wound healing process (Huflejt et al. J. Biol. Chem. 1997 272(22):14294-303).

WO98/22139 describes differential expression of 25 galectin-4 in human breast tumor cells. Other members of the galectin superfamily including galectin 8, 9, 10 and 10SV have been described as markers in the diagnosis of cancers including Hodgkin's disease, breast, ovarian, prostate, bone, liver, lung, pancreatic and splenic (see WO 98/15624).

30 In the present invention, methods are provided for detecting, diagnosing, monitoring, staging, prognosticating, imaging and treating gastrointestinal cancer via the gastrointestinal specific genes referred to herein as GSGs and more specifically as Cln114 and Cln115. For purposes of the 35 present invention, GSG refers, among other things, to native

protein expressed by the gene comprising a polynucleotide sequence of SEQ ID NO:1 or 3. Amino acid sequences encoded by the polynucleotides of SEQ ID NO:1 and 3 are depicted in SEQ ID NO:2 and 4, respectively. By "GSG" it is also meant 5 herein polynucleotides which, due to degeneracy in genetic coding, comprise variations in nucleotide sequence as compared to SEQ ID NO: 1 or 3, but which still encode the same protein. In the alternative, what is meant by GSG as used herein, means the native mRNA encoded by the gene comprising the 10 polynucleotide sequence of SEQ ID NO: 1 or 3, levels of the gene comprising the polynucleotide sequence of SEQ ID NO: 1 or 3, or levels of a polynucleotide which is capable of hybridizing under stringent conditions to the antisense sequence of SEQ ID NO: 1 or 3.

15 Other objects, features, advantages and aspects of the present invention will become apparent to those of skill in the art from the following description. It should be understood, however, that the following description and the specific examples, while indicating preferred embodiments of 20 the invention are given by way of illustration only. Various changes and modifications within the spirit and scope of the disclosed invention will become readily apparent to those skilled in the art from reading the following description and from reading the other parts of the present disclosure.

25

SUMMARY OF THE INVENTION

Toward these ends, and others, it is an object of the present invention to provide a method for diagnosing the presence of gastrointestinal cancer by analyzing for changes 30 in levels of GSG in cells, tissues or bodily fluids compared with levels of GSG in preferably the same cells, tissues, or bodily fluid type of a normal human control, wherein a change in levels of GSG in the patient versus the normal human control is associated with gastrointestinal cancer.

Further provided is a method of diagnosing metastatic gastrointestinal cancer in a patient having gastrointestinal cancer which is not known to have metastasized by identifying a human patient suspected of having gastrointestinal cancer 5 that has metastasized; analyzing a sample of cells, tissues, or bodily fluid from such patient for GSG; comparing the GSG levels in such cells, tissues, or bodily fluid with levels of GSG in preferably the same cells, tissues, or bodily fluid type of a normal human control, wherein a decrease in GSG 10 levels in the patient versus the normal human control is associated with gastrointestinal cancer which has metastasized.

Also provided by the invention is a method of staging gastrointestinal cancer in a human which has such cancer by 15 identifying a human patient having such cancer; analyzing a sample of cells, tissues, or bodily fluid from such patient for GSG; comparing GSG levels in such cells, tissues, or bodily fluid with levels of GSG in preferably the same cells, tissues, or bodily fluid type of a normal human control 20 sample, wherein a decrease in GSG levels in the patient versus the normal human control is associated with a cancer which is progressing and an increase in the levels of GSG is associated with a cancer which is regressing or in remission.

Further provided is a method of monitoring 25 gastrointestinal cancer in a human having such cancer for the onset of metastasis. The method comprises identifying a human patient having such cancer that is not known to have metastasized; periodically analyzing a sample of cells, tissues, or bodily fluids from such patient for GSG; comparing 30 the GSG levels in such cells, tissues, or bodily fluids with levels of GSG in preferably the same cells, tissues, or bodily fluid type of a normal human control sample, wherein a decrease in GSG levels in the patient versus the normal human control is associated with a cancer which has metastasized.

Further provided is a method of monitoring the change in stage of gastrointestinal cancer in a human having such cancer by looking at levels of GSG in a human having such cancer. The method comprises identifying a human patient 5 having such cancer; periodically analyzing a sample of cells, tissues, or bodily fluids from such patient for GSG; comparing the GSG levels in such cells, tissues, or bodily fluids with levels of GSG in preferably the same cells, tissues, or bodily fluid type of a normal human control sample, wherein a 10 decrease in GSG levels in the patient versus the normal human control is associated with a cancer which is progressing and an increase in the levels of GSG is associated with a cancer which is regressing or in remission.

Further provided are methods of designing new therapeutic agents targeted to a GSG for use in imaging and treating gastrointestinal cancer. For example, in one embodiment, therapeutic agents such as antibodies targeted against GSG or fragments of such antibodies can be used to detect or image localization of GSG in a patient for the purpose of detecting or diagnosing a disease or condition. In this embodiment, a decrease in the amount of labeled antibody detected as compared to normal tissue would be indicative of tumor metastases or growth. Such antibodies can be polyclonal, monoclonal, or omniconal or prepared by molecular biology techniques. The term "antibody", as used herein and throughout the instant specification is also meant to include aptamers and single-stranded oligonucleotides such as those derived from an in vitro evolution protocol referred to as SELEX and well known to those skilled in the art.

Antibodies can be labeled with a variety of detectable labels including, but not limited to, radioisotopes and paramagnetic metals. Therapeutic agents such as small molecules or antibodies which increase the concentration and/or activity of GSGs can also be used in the treatment of diseases

characterized by underexpression of GSG. Such agents can be readily identified in accordance with the teachings herein.

Other objects, features, advantages and aspects of the present invention will become apparent to those of skill in the art from the following description. It should be understood, however, that the following description and the specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only. Various changes and modifications within the spirit and scope of the disclosed invention will become readily apparent to those skilled in the art from reading the following description and from reading the other parts of the present disclosure.

GLOSSARY

15 The following illustrative explanations are provided to facilitate understanding of certain terms used frequently herein. The explanations are provided as a convenience and are not limitative of the invention.

DIGESTION of DNA refers to catalytic cleavage of the DNA 20 with a restriction enzyme that acts only at certain sequences in the DNA. The various restriction enzymes referred to herein are commercially available and their reaction conditions, cofactors and other requirements for use are known and routine to the skilled artisan.

25 For analytical purposes, typically, 1 μ g of plasmid or DNA fragment is digested with about 2 units of enzyme in about 20 μ l of reaction buffer. For the purpose of isolating DNA fragments for plasmid construction, typically 5 to 50 μ g of DNA are digested with 20 to 250 units of enzyme in 30 proportionately larger volumes.

Appropriate buffers and substrate amounts for particular restriction enzymes are described in standard laboratory manuals, such as those referenced below, and they are specified by commercial suppliers.

Incubation times of about 1 hour at 37°C are ordinarily used, but conditions may vary in accordance with standard procedures, the supplier's instructions and the particulars of the reaction. After digestion, reactions may be analyzed, 5 and fragments may be purified by electrophoresis through an agarose or polyacrylamide gel, using well known methods that are routine for those skilled in the art.

GENETIC ELEMENT generally means a polynucleotide comprising a region that encodes a polypeptide or a region 10 that regulates transcription or translation or other processes important to expression of the polypeptide in a host cell, or a polynucleotide comprising both a region that encodes a polypeptide and a region operably linked thereto that regulates expression.

15 Genetic elements may be comprised within a vector that replicates as an episomal element; that is, as a molecule physically independent of the host cell genome. They may be comprised within mini-chromosomes, such as those that arise during amplification of transfected DNA by methotrexate 20 selection in eukaryotic cells. Genetic elements also may be comprised within a host cell genome; not in their natural state but, rather, following manipulation such as isolation, cloning and introduction into a host cell in the form of purified DNA or in a vector, among others.

25 ISOLATED means altered "by the hand of man" from its natural state; i.e., that, if it occurs in nature, it has been changed or removed from its original environment, or both.

For example, a naturally occurring polynucleotide or a polypeptide naturally present in a living animal in its 30 natural state is not "isolated," but the same polynucleotide or polypeptide separated from the coexisting materials of its natural state is "isolated", as the term is employed herein. For example, with respect to polynucleotides, the term isolated means that it is separated from the chromosome and 35 cell in which it naturally occurs.

As part of or following isolation, such polynucleotides can be joined to other polynucleotides, such as DNAs, for mutagenesis, to form fusion proteins, and for propagation or expression in a host, for instance. The isolated 5 polynucleotides, alone or joined to other polynucleotides such as vectors, can be introduced into host cells, in culture or in whole organisms. When introduced into host cells in culture or in whole organisms, such DNAs still would be isolated, as the term is used herein, because they would not be in their 10 naturally occurring form or environment. Similarly, the polynucleotides and polypeptides may occur in a composition, such as media formulations, solutions for introduction of polynucleotides or polypeptides, for example, into cells, compositions or solutions for chemical or enzymatic reactions, 15 for instance, which are not naturally occurring compositions, and, therein remain isolated polynucleotides or polypeptides within the meaning of that term as it is employed herein.

LIGATION refers to the process of forming phosphodiester bonds between two or more polynucleotides, which most often 20 are double stranded DNAs. Techniques for ligation are well known to the art and protocols for ligation are described in standard laboratory manuals and references, such as, for instance, Sambrook et al., MOLECULAR CLONING, A LABORATORY MANUAL, 2nd Ed.; Cold Spring Harbor Laboratory Press, Cold 25 Spring Harbor, N.Y. (1989) and Maniatis et al., pg. 146, as cited below.

OLIGONUCLEOTIDE(S) refers to relatively short polynucleotides. Often the term refers to single-stranded deoxyribonucleotides, but it can refer as well to single- or 30 double-stranded ribonucleotides, RNA:DNA hybrids and double-stranded DNAs, among others.

Oligonucleotides, such as single-stranded DNA probe oligonucleotides, often are synthesized by chemical methods, such as those implemented on automated oligonucleotide 35 synthesizers. However, oligonucleotides can be made by a

variety of other methods, including *in vitro* recombinant DNA-mediated techniques and by expression of DNAs in cells and organisms.

Initially, chemically synthesized DNAs typically are obtained without a 5' phosphate. The 5' ends of such oligonucleotides are not substrates for phosphodiester bond formation by ligation reactions that employ DNA ligases typically used to form recombinant DNA molecules. Where ligation of such oligonucleotides is desired, a phosphate can be added by standard techniques, such as those that employ a kinase and ATP.

The 3' end of a chemically synthesized oligonucleotide generally has a free hydroxyl group and, in the presence of a ligase, such as T4 DNA ligase, readily will form a phosphodiester bond with a 5' phosphate of another polynucleotide, such as another oligonucleotide. As is well known, this reaction can be prevented selectively, where desired, by removing the 5' phosphates of the other polynucleotide(s) prior to ligation.

PLASMIDS generally are designated herein by a lower case "p" preceded and/or followed by capital letters and/or numbers, in accordance with standard naming conventions that are familiar to those of skill in the art. Starting plasmids disclosed herein are either commercially available, publicly available on an unrestricted basis, or can be constructed from available plasmids by routine application of well known, published procedures. Many plasmids and other cloning and expression vectors that can be used in accordance with the present invention are well known and readily available to those of skill in the art. Moreover, those of skill readily may construct any number of other plasmids suitable for use in the invention. The properties, construction and use of such plasmids, as well as other vectors, in the present invention will be readily apparent to those of skill from the present disclosure.

POLYNUCLEOTIDE(S) generally refers to any polyribonucleotide or polydeoxribonucleotide, which may be unmodified RNA or DNA or modified RNA or DNA. Thus, for instance, polynucleotides as used herein refers to, among 5 others, single- and double-stranded DNA, DNA that is a mixture of single-and double-stranded regions, single- and double-stranded RNA, and RNA that is mixture of single- and double-stranded regions, hybrid molecules comprising DNA and RNA that may be single-stranded or, more typically, double-stranded or 10 a mixture of single- and double-stranded regions. In addition, polynucleotide as used herein refers to triple-stranded regions comprising RNA or DNA or both RNA and DNA. The strands in such regions may be from the same molecule or from different molecules. The regions may include all of one or 15 more of the molecules, but more typically involve only a region of some of the molecules. One of the molecules of a triple-helical region often is an oligonucleotide.

As used herein, the term polynucleotide includes DNAs or RNAs as described above that contain one or more modified 20 bases. Thus, DNAs or RNAs with backbones modified for stability or for other reasons are "polynucleotides" as that term is intended herein. Moreover, DNAs or RNAs comprising unusual bases, such as inosine, or modified bases, such as tritylated bases, to name just two examples, are 25 polynucleotides as the term is used herein.

It will be appreciated that a great variety of modifications have been made to DNA and RNA that serve many useful purposes known to those of skill in the art. The term polynucleotide as it is employed herein embraces such 30 chemically, enzymatically or metabolically modified forms of polynucleotides, as well as the chemical forms of DNA and RNA characteristic of viruses and cells, including simple and complex cells, inter alia.

POLYPEPTIDES, as used herein, includes all polypeptides 35 as described below. The basic structure of polypeptides is

well known and has been described in innumerable textbooks and other publications in the art. In this context, the term is used herein to refer to any peptide or protein comprising two or more amino acids joined to each other in a linear chain by 5 peptide bonds. As used herein, the term refers to both short chains, which also commonly are referred to in the art as peptides, oligopeptides and oligomers, for example, and to longer chains, which generally are referred to in the art as proteins, of which there are many types. It will be 10 appreciated that polypeptides often contain amino acids other than the 20 amino acids commonly referred to as the 20 naturally occurring amino acids, and that many amino acids, including the terminal amino acids, may be modified in a given polypeptide, either by natural processes, such as processing 15 and other post-translational modifications, or by chemical modification techniques which are well known to the art. Even the common modifications that occur naturally in polypeptides are too numerous to list exhaustively here, but they are well described in basic texts and in more detailed monographs, as 20 well as in voluminous research literature, and they are well known to those of skill in the art.

Known modifications which may be present in polypeptides of the present invention include, to name an illustrative few, acetylation, acylation, ADP-ribosylation, amidation, covalent 25 attachment of flavin, covalent attachment of a heme moiety, covalent attachment of a nucleotide or nucleotide derivative, covalent attachment of a lipid or lipid derivative, covalent attachment of phosphotidylinositol, cross-linking, cyclization, disulfide bond formation, demethylation, 30 formation of covalent cross-links, formation of cystine, formation of pyroglutamate, formylation, gamma-carboxylation, glycosylation, GPI anchor formation, hydroxylation, iodination, methylation, myristoylation, oxidation, proteolytic processing, phosphorylation, prenylation, 35 racemization, selenylation, sulfation, transfer-RNA mediated

addition of amino acids to proteins such as arginylation, and ubiquitination.

Such modifications are well known to those of skill and have been described in great detail in the scientific literature. Several particularly common modifications, glycosylation, lipid attachment, sulfation, gamma-carboxylation of glutamic acid residues, hydroxylation and ADP-ribosylation, for instance, are described in most basic texts, such as, for instance PROTEINS STRUCTURE AND MOLECULAR PROPERTIES, 2nd Ed., T. E. Creighton, W. H. Freeman and Company, New York (1993). Many detailed reviews are available on this subject, such as, for example, those provided by Wold, F., Posttranslational Protein Modifications: Perspectives and Prospects, pgs. 1-12 in POSTTRANSLATIONAL COVALENT MODIFICATION OF PROTEINS, B. C. Johnson, Ed., Academic Press, New York (1983); Seifter et al., Analysis for protein modifications and nonprotein cofactors, Meth. Enzymol. 182: 626-646 (1990) and Rattan et al., Protein Synthesis: Posttranslational Modifications and Aging, Ann. N.Y. Acad. Sci. 663: 48-62 (1992).

It will be appreciated, as is well known and as noted above, that polypeptides are not always entirely linear. For instance, polypeptides may be branched as a result of ubiquitination, and they may be circular, with or without branching, generally as a result of posttranslation events, including natural processing events and events brought about by human manipulation which do not occur naturally. Circular, branched and branched circular polypeptides may be synthesized by non-translation natural process and by entirely synthetic methods, as well.

Modifications can occur anywhere in a polypeptide, including the peptide backbone, the amino acid side-chains and the amino or carboxyl termini. In fact, blockage of the amino or carboxyl group in a polypeptide, or both, by a covalent modification, is common in naturally occurring and synthetic

polypeptides and such modifications may be present in polypeptides of the present invention, as well. For instance, the amino terminal residue of polypeptides made in *E. coli*, prior to proteolytic processing, almost invariably will be N-
5 formylmethionine.

The modifications that occur in a polypeptide often will be a function of how it is made. For polypeptides made by expressing a cloned gene in a host, for instance, the nature and extent of the modifications in large part will be
10 determined by the host cell posttranslational modification capacity and the modification signals present in the polypeptide amino acid sequence. For instance, as is well known, glycosylation often does not occur in bacterial hosts such as *E. coli*. Accordingly, when glycosylation is desired,
15 a polypeptide should be expressed in a glycosylating host, generally a eukaryotic cell. Insect cells often carry out the same posttranslational glycosylations as mammalian cells and, for this reason, insect cell expression systems have been developed to express efficiently mammalian proteins having
20 native patterns of glycosylation, *inter alia*. Similar considerations apply to other modifications.

It will be appreciated that the same type of modification may be present in the same or varying degree at several sites in a given polypeptide. Also, a given
25 polypeptide may contain many types of modifications.

In general, as used herein, the term polypeptide encompasses all such modifications, particularly those that are present in polypeptides synthesized by expressing a polynucleotide in a host cell.

30 VARIANT(S) of polynucleotides or polypeptides, as the term is used herein, are polynucleotides or polypeptides that differ from a reference polynucleotide or polypeptide, respectively. Variants in this sense are described below and elsewhere in the present disclosure in greater detail.

A variant may comprise a polynucleotide that differs in nucleotide sequence from another, reference polynucleotide. Generally, differences are limited so that the nucleotide sequences of the reference and the variant are closely similar overall and, in many regions, identical.

As noted below, changes in the nucleotide sequence of the variant may be silent. That is, they may not alter the amino acids encoded by the polynucleotide. Where alterations are limited to silent changes of this type a variant will encode a polypeptide with the same amino acid sequence as the reference. Also as noted below, changes in the nucleotide sequence of the variant may alter the amino acid sequence of a polypeptide encoded by the reference polynucleotide. Such nucleotide changes may result in amino acid substitutions, additions, deletions, fusions and truncations in the polypeptide encoded by the reference sequence, as discussed below.

A variant may also comprise a polypeptide that differs in amino acid sequence from another, reference polypeptide. Generally, differences are limited so that the sequences of the reference and the variant are closely similar overall and, in many region, identical.

A variant and reference polypeptide may differ in amino acid sequence by one or more substitutions, additions, deletions, fusions and truncations, which may be present in any combination.

RECEPTOR MOLECULE, as used herein, refers to molecules which bind or interact specifically with GSG polypeptides of the present invention and is inclusive not only of classic receptors, which are preferred, but also other molecules that specifically bind to or interact with polypeptides of the invention (which also may be referred to as "binding molecules" and "interaction molecules," respectively and as "GSG binding or interaction molecules", "Cln114 and Cln115 binding molecules" and "Cln114 and Cln115 interaction

molecules." Binding between polypeptides of the invention and such molecules, including receptor or binding or interaction molecules may be exclusive to polypeptides of the invention, which is very highly preferred, or it may be highly specific 5 for polypeptides of the invention, which is highly preferred, or it may be highly specific to a group of proteins that includes polypeptides of the invention, which is preferred, or it may be specific to several groups of proteins at least one of which includes polypeptides of the invention.

10 Receptors also may be non-naturally occurring, such as antibodies and antibody-derived reagents that bind to polypeptides of the invention.

DETAILED DESCRIPTION OF THE INVENTION

15 The present invention relates to diagnostic assays and methods, both quantitative and qualitative for detecting, diagnosing, monitoring, staging and prognosticating cancers by comparing levels of GSG in a human patient with those of GSG in a normal human control. The present invention also 20 relates to agents and methods for identifying and using agents which modulate GSG activity and/or levels to treat diseases or disorders associated with decreased levels of GSG. For purposes of the present invention, what is meant by GSG levels is, among other things, native protein expressed by the gene 25 comprising a polynucleotide sequence of SEQ ID NO: 1 or 3. Amino acid sequences encoded by the polynucleotide sequences of SEQ ID NO:1 and 3 are depicted in SEQ ID NO:2 and 4, respectively. By "GSG" it is also meant herein polynucleotides which, due to degeneracy in genetic coding, 30 comprise variations in nucleotide sequence as compared to SEQ ID NO: 1 or 3, but which still encode the same protein. The native protein being detected may be whole, a breakdown product, a complex of molecules or chemically modified. In the alternative, what is meant by GSG as used herein, means 35 the native mRNA encoded by the gene comprising the

polynucleotide sequence of SEQ ID NO: 1 or 3, levels of the gene comprising the polynucleotide sequence of SEQ ID NO: 1 or 3, or levels of a polynucleotide which is capable of hybridizing under stringent conditions to the antisense 5 sequence of SEQ ID NO: 1 or 3. Such levels are preferably determined in at least one of cells, tissues and/or bodily fluids, including determination of normal and abnormal levels. Thus, for instance, a diagnostic assay in accordance with the invention for diagnosing underexpression of GSG protein 10 compared to normal control bodily fluids, cells, or tissue samples may be used to diagnose the presence of gastrointestinal cancer.

All the methods of the present invention may optionally include determining the levels of other cancer markers as well 15 as GSG. Other cancer markers, in addition to GSG, useful in the present invention will depend on the cancer being tested and are known to those of skill in the art.

Diagnostic Assays

The present invention provides methods for diagnosing 20 the presence of cancer, and in particular gastrointestinal cancer including stomach, small intestine and colon cancer, by analyzing for changes in levels of GSG in cells, tissues or bodily fluids compared with levels of GSG in cells, tissues or bodily fluids of preferably the same type from a normal 25 human control, wherein a decrease in levels of GSG in the patient versus the normal human control is associated with the presence of gastrointestinal cancer.

Without limiting the instant invention, typically, for 30 a quantitative diagnostic assay a positive result indicating the patient being tested has cancer is one in which cells, tissues or bodily fluid levels of the cancer marker, such as GSG, are at least two times lower, and most preferably are at least five times lower, than in preferably the same cells, tissues or bodily fluid of a normal human control.

The present invention also provides a method of diagnosing metastatic gastrointestinal cancer in a patient having gastrointestinal cancer which has not yet metastasized for the onset of metastasis. In the method of the present 5 invention, a human cancer patient suspected of having gastrointestinal cancer which may have metastasized (but which was not previously known to have metastasized) is identified. This is accomplished by a variety of means known to those of skill in the art.

10 In the present invention, determining the presence of GSG levels in cells, tissues or bodily fluid, is particularly useful for discriminating between gastrointestinal cancer which has not metastasized and gastrointestinal cancer which has metastasized. Existing techniques have difficulty 15 discriminating between gastrointestinal cancer which has metastasized and gastrointestinal cancer which has not metastasized and proper treatment selection is often dependent upon such knowledge.

In the present invention, the cancer marker levels 20 measured in such cells, tissues or bodily fluid is GSG, and are compared with levels of GSG in preferably the same cells, tissues or bodily fluid type of a normal human control. That is, if the cancer marker being observed is GSG in serum, this level is preferably compared with the level of GSG in serum 25 of a normal human control. A decrease in the GSG in the patient versus the normal human control is associated with gastrointestinal cancer which has metastasized.

Without limiting the instant invention, typically, for 30 a quantitative diagnostic assay a positive result indicating the cancer in the patient being tested or monitored has metastasized is one in which cells, tissues or bodily fluid levels of the cancer marker, such as GSG, are at least two times lower, and most preferably are at least five times lower, than in preferably the same cells, tissues or bodily 35 fluid of a normal patient.

Normal human control as used herein includes a human patient without cancer and/or non cancerous samples from the patient; in the methods for diagnosing or monitoring for metastasis, normal human control may preferably also include 5 samples from a human patient that is determined by reliable methods to have gastrointestinal cancer which has not metastasized.

Staging

The invention also provides a method of staging 10 gastrointestinal cancer in a human patient. The method comprises identifying a human patient having such cancer and analyzing cells, tissues or bodily fluid from such human patient for GSG. The GSG levels determined in the patient are then compared with levels of GSG in preferably the same cells, 15 tissues or bodily fluid type of a normal human control, wherein a decrease in GSG levels in the human patient versus the normal human control is associated with a cancer which is progressing and an increase in the levels of GSG (but still decreased over true normal levels) is associated with a cancer 20 which is regressing or in remission.

Monitoring

Further provided is a method of monitoring 25 gastrointestinal cancer in a human patient having such cancer for the onset of metastasis. The method comprises identifying a human patient having such cancer that is not known to have metastasized; periodically analyzing cells, tissues or bodily fluid from such human patient for GSG; and comparing the GSG levels determined in the human patient with levels of GSG in preferably the same cells, tissues or bodily fluid type of a 30 normal human control, wherein a decrease in GSG levels in the human patient versus the normal human control is associated with a cancer which has metastasized. In this method, normal human control samples may also include prior patient samples.

Further provided by this invention is a method of 35 monitoring the change in stage of gastrointestinal cancer in

a human patient having such cancer. The method comprises identifying a human patient having such cancer; periodically analyzing cells, tissues or bodily fluid from such human patient for GSG; and comparing the GSG levels determined in 5 the human patient with levels of GSG in preferably the same cells, tissues or bodily fluid type of a normal human control, wherein a decrease in GSG levels in the human patient versus the normal human control is associated with a cancer which is progressing in stage and an increase in the levels of GSG is 10 associated with a cancer which is regressing in stage or in remission. In this method, normal human control samples may also include prior patient samples.

Monitoring a patient for onset of metastasis is periodic and preferably done on a quarterly basis. However, this may 15 be done more or less frequently depending on the cancer, the particular patient, and the stage of the cancer.

Prognostic Testing and Clinical Trial Monitoring

The methods described herein can further be utilized as prognostic assays to identify subjects having or at risk of 20 developing a disease or disorder associated with decreased levels of GSG. The present invention provides a method in which a test sample is obtained from a human patient and GSG is detected. The presence of lower GSG levels as compared to normal human controls is diagnostic for the human patient 25 being at risk for developing cancer, particularly gastrointestinal cancer.

The effectiveness of therapeutic agents to increase expression or activity of the GSGs of the invention can also be monitored by analyzing levels of expression of the GSGs in 30 a human patient in clinical trials or in in vitro screening assays such as in human cells. In this way, the gene expression pattern can serve as a marker, indicative of the physiological response of the human patient, or cells as the case may be, to the agent being tested.

35 Detection of genetic lesions or mutations

The methods of the present invention can also be used to detect genetic lesions or mutations in GSG, thereby determining if a human with the genetic lesion is at risk for gastrointestinal cancer or has gastrointestinal cancer.

5 Genetic lesions can be detected, for example, by ascertaining the existence of a deletion and/or addition and/or substitution of one or more nucleotides from the GSGs of this invention, a chromosomal rearrangement of GSG, aberrant modification of GSG (such as of the methylation pattern of the
10 genomic DNA), the presence of a non-wild type splicing pattern of a mRNA transcript of GSG, allelic loss of GSG, and/or inappropriate post-translational modification of GSG protein. Methods to detect such lesions in the GSG of this invention are known to those of skill in the art.

15 **Assay Techniques**

Assay techniques that can be used to determine levels of gene expression (including protein levels), such as GSG of the present invention, in a sample derived from a patient are well known to those of skill in the art. Such assay methods 20 include, without limitation, radioimmunoassays, reverse transcriptase PCR (RT-PCR) assays, immunohistochemistry assays, *in situ* hybridization assays, competitive-binding assays, Western Blot analyses, ELISA assays and proteomic approaches: two-dimensional gel electrophoresis (2D 25 electrophoresis) and non-gel based approaches such as mass spectrometry or protein interaction profiling. Among these, ELISAs are frequently preferred to diagnose a gene's expressed protein in biological fluids.

An ELISA assay initially comprises preparing an 30 antibody, if not readily available from a commercial source, specific to GSG, preferably a monoclonal antibody. In addition a reporter antibody generally is prepared which binds specifically to GSG. The reporter antibody is attached to a detectable reagent such as radioactive, fluorescent or

enzymatic reagent, for example horseradish peroxidase enzyme or alkaline phosphatase.

To carry out the ELISA, antibody specific to GSG is incubated on a solid support, e.g. a polystyrene dish, that binds the antibody. Any free protein binding sites on the dish are then covered by incubating with a non-specific protein such as bovine serum albumin. Next, the sample to be analyzed is incubated in the dish, during which time GSG binds to the specific antibody attached to the polystyrene dish. Unbound sample is washed out with buffer. A reporter antibody specifically directed to GSG and linked to a detectable reagent such as horseradish peroxidase is placed in the dish resulting in binding of the reporter antibody to any monoclonal antibody bound to GSG. Unattached reporter antibody is then washed out. Reagents for peroxidase activity, including a colorimetric substrate are then added to the dish. Immobilized peroxidase, linked to GSG antibodies, produces a colored reaction product. The amount of color developed in a given time period is proportional to the amount of GSG polypeptide present in the sample. Quantitative results typically are obtained by reference to a standard curve.

A competition assay can also be employed wherein antibodies specific to GSG are attached to a solid support and labeled GSG and a sample derived from the host are passed over the solid support. The amount of label detected which is attached to the solid support can be correlated to a quantity of GSG in the sample.

Using all or a portion of a nucleic acid sequence of GSG of the present invention as a hybridization probe, nucleic acid methods can also be used to detect GSG mRNA as a marker for gastrointestinal cancer. Polymerase chain reaction (PCR) and other nucleic acid methods, such as ligase chain reaction (LCR) and nucleic acid sequence based amplification (NASBA), can be used to detect malignant cells for diagnosis and

monitoring of various malignancies. For example, reverse-transcriptase PCR (RT-PCR) is a powerful technique which can be used to detect the presence of a specific mRNA population in a complex mixture of thousands of other mRNA species. In 5 RT-PCR, an mRNA species is first reverse transcribed to complementary DNA (cDNA) with use of the enzyme reverse transcriptase; the cDNA is then amplified as in a standard PCR reaction. RT-PCR can thus reveal by amplification the presence of a single species of mRNA. Accordingly, if the 10 mRNA is highly specific for the cell that produces it, RT-PCR can be used to identify the presence of a specific type of cell.

Hybridization to clones or oligonucleotides arrayed on a solid support (i.e. gridding) can be used to both detect the 15 expression of and quantitate the level of expression of that gene. In this approach, a cDNA encoding the GSG gene is fixed to a substrate. The substrate may be of any suitable type including but not limited to glass, nitrocellulose, nylon or plastic. At least a portion of the DNA encoding the GSG gene 20 is attached to the substrate and then incubated with the analyte, which may be RNA or a complementary DNA (cDNA) copy of the RNA, isolated from the tissue of interest. Hybridization between the substrate bound DNA and the analyte can be detected and quantitated by several means including but 25 not limited to radioactive labeling or fluorescence labeling of the analyte or a secondary molecule designed to detect the hybrid. Quantitation of the level of gene expression can be done by comparison of the intensity of the signal from the analyte compared with that determined from known standards. 30 The standards can be obtained by *in vitro* transcription of the target gene, quantitating the yield, and then using that material to generate a standard curve.

Of the proteomic approaches, 2D electrophoresis is a technique well known to those in the art. Isolation of 35 individual proteins from a sample such as serum is

accomplished using sequential separation of proteins by different characteristics usually on polyacrylamide gels. First, proteins are separated by size using an electric current. The current acts uniformly on all proteins, so 5 smaller proteins move farther on the gel than larger proteins. The second dimension applies a current perpendicular to the first and separates proteins not on the basis of size but on the specific electric charge carried by each protein. Since no two proteins with different sequences are identical on the 10 basis of both size and charge, the result of a 2D separation is a square gel in which each protein occupies a unique spot. Analysis of the spots with chemical or antibody probes, or subsequent protein microsequencing can reveal the relative abundance of a given protein and the identity of the proteins 15 in the sample.

The above tests can be carried out on samples derived from a variety of cells, bodily fluids and/or tissue extracts such as homogenates or solubilized tissue obtained from a patient. Tissue extracts are obtained routinely from tissue 20 biopsy and autopsy material. Bodily fluids useful in the present invention include blood, urine, saliva or any other bodily secretion or derivative thereof. By blood it is meant to include whole blood, plasma, serum or any derivative of blood.

25 *In Vivo Targeting of GSG/Monitoring and Treating
Gastrointestinal Cancer Therapy*

Identification of these GSGs is also useful in the rational design of new therapeutics for imaging and monitoring cancer treatment, and in particular gastrointestinal cancer 30 treatment. For example, in one embodiment, antibodies which specifically bind to GSG can be raised and used *in vivo* in patients suffering from gastrointestinal cancer to monitor decreases or increases in GSG levels indicative of the efficacy of the treatment and/or the spreading of the cancer. 35 Antibodies which specifically bind GSG can be injected into

a patient having gastrointestinal cancer for diagnostic and/or therapeutic purposes. Thus, another aspect of the present invention provides for a method for monitoring treatment of gastrointestinal cancer in a human patient by administering
5 to the patient a GSG antibody.

The preparation and use of antibodies for *in vivo* diagnosis and treatment is well known in the art. For example, antibody-chelators labeled with Indium-111 have been described for use in the radioimmunoscinigraphic imaging of
10 carcinoembryonic antigen expressing tumors (Sumerdon et al. Nucl. Med. Biol. 1990 17:247-254). In particular, these antibody-chelators have been used in detecting tumors in patients suspected of having recurrent colorectal cancer (Griffin et al. J. Clin. Onc. 1991 9:631-640). Antibodies
15 with paramagnetic ions as labels for use in magnetic resonance imaging have also been described (Lauffer, R.B. Magnetic Resonance in Medicine 1991 22:339-342). Antibodies directed against GSG can be used in a similar manner. Labeled antibodies which specifically bind GSG can be injected into
20 patients suspected of having gastrointestinal cancer for the purpose of diagnosing or staging of the disease status of the patient. The label used will be selected in accordance with the imaging modality to be used. For example, radioactive labels such as Indium-111, Technetium-99m or Iodine-131 can
25 be used for planar scans or single photon emission computed tomography (SPECT). Positron emitting labels such as Fluorine-19 can be used in positron emission tomography. Paramagnetic ions such as Gadlinium (III) or Manganese (II) can be used in magnetic resonance imaging (MRI). Presence or
30 absence of the label, as compared to imaging of normal tissue, permits determination of the spread of the cancer. The amount of label within an organ or tissue also allows determination of the presence or absence of cancer in that organ or tissue.

Antibodies which can be used in *in vivo* methods include
35 polyclonal, monoclonal and omniclonal antibodies and

antibodies prepared via molecular biology techniques. Antibody fragments and aptamers and single-stranded oligonucleotides such as those derived from an *in vitro* evolution protocol referred to as SELEX and well known to 5 those skilled in the art can also be used.

Small molecules predicted via computer imaging to specifically bind to regions of GSG can also be designed, synthesized and tested for use in the imaging and treatment of gastrointestinal cancer. Further, libraries of molecules 10 can be screened for potential anticancer agents by assessing the ability of the molecule to bind to the GSGs identified herein. Molecules identified in the library as being capable of binding to GSG are key candidates for further evaluation for use in the treatment of gastrointestinal cancer. In a 15 preferred embodiment, these molecules will upregulate expression and/or activity of GSG in cells.

Antibodies

GSG polypeptides, their fragments or other derivatives, or analogs thereof, or cells expressing them can be used as 20 an immunogen to produce antibodies thereto. These antibodies can be, for example, polyclonal or monoclonal antibodies. The present invention also includes chimeric, single chain, and humanized antibodies, as well as Fab fragments, or the product of an Fab expression library. Various procedures known in the 25 art may be used for the production of such antibodies and fragments.

Antibodies generated against the polypeptides corresponding to a sequence of the present invention can be obtained by direct injection of the polypeptides into an 30 animal or by administering the polypeptides to an animal, preferably a nonhuman. The antibody so obtained will then bind the polypeptides itself. In this manner, even a sequence encoding only a fragment of the polypeptide can be used to generate antibodies binding the whole native polypeptide. Such

antibodies can then be used to isolate the polypeptide from tissue expressing that polypeptide.

For preparation of monoclonal antibodies, techniques which provide antibodies produced by continuous cell line cultures can be used. Examples include the hybridoma technique (Kohler, G. and Milstein, C., *Nature* 256: 495-497 (1975), the trioma technique, the human B-cell hybridoma technique (Kozbor et al., *Immunology Today* 4: 72 (1983) and the EBV-hybridoma technique to produce human monoclonal antibodies (Cole et al., pg. 77-96 in *MONOCLONAL ANTIBODIES AND CANCER THERAPY*, Alan R. Liss, Inc. (1985).

Techniques described for the production of single chain antibodies (U.S. Pat. No. 4,946,778) can be adapted to produce single chain antibodies to immunogenic polypeptide products of this invention. Also, transgenic mice, or other organisms such as other mammals, may be used to express humanized antibodies to immunogenic polypeptide products of this invention.

The above-described antibodies may be employed to isolate or to identify clones expressing the polypeptide or purify the polypeptide of the present invention by attachment of the antibody to a solid support for isolation and/or purification by affinity chromatography.

Using "Peptide Structure" analysis in GCG, the following potential antigenic epitopes have been identified:

Pro ⁷ -Pro ²²	PAPGYQPTYNPTLPYYQP (SEQ ID NO:5)
Pro ⁶⁶ -Arg ⁹¹	PRFDGWDKVVFNTLQGGKGWGSEERKR (SEQ ID NO:6)
Pro ¹⁵⁴ -Asn ¹⁷⁷	PLRPQGPMMPPYPGPQPHCHQQQLN (SEQ ID NO:7)
30 Trp ²⁵⁶ -Pro ²⁷⁰	WGSEEKKITHNPFGP (SEQ ID NO:8)

Screening Assays

The present invention also provides methods for identifying modulators which bind to GSG polypeptides or have a modulatory effect on the expression or activity of GSG

polypeptides. Modulators which increase the expression or activity of GSG polypeptides are believed to be useful in treating gastrointestinal cancer. Such screening assays are known to those of skill in the art and include, without limitation, cell-based assays and cell free assays.

For example, genes encoding proteins that bind GSGs, such as receptor proteins, can be identified by numerous methods known to those of skill in the art, for example, ligand panning and FACS sorting. Such methods are described in many laboratory manuals such as, for instance, Coligan et al., Current Protocols in Immunology 1(2): Chapter 5 (1991). Expression cloning can also be employed for this purpose. To this end, polyadenylated RNA is prepared from a cell responsive to a GSG of the present invention; a cDNA library is created from this RNA; the library is divided into pools; and the pools are transfected individually into cells that are not responsive to the GSG. The transfected cells then are exposed to labeled GSG. The GSGs of the present invention can be labeled by a variety of well-known techniques including standard methods of radio-iodination or inclusion of a recognition site for a site-specific protein kinase. Following exposure, the cells are fixed and binding of cytostatin is determined. In a preferred embodiment, these procedures are carried out on glass slides. Pools of cDNA that produce GSG-binding cells are then identified. Sub-pools are prepared from these positives, transfected into host cells and screened as described above. Using an iterative sub-pooling and re-screening process, one or more single clones that encode the putative binding molecule, such as a receptor molecule, can be isolated.

Alternatively a labeled ligand can be photoaffinity-linked to a cell extract, such as a membrane or a membrane extract, prepared from cells that express a molecule that it binds, such as a receptor molecule. Cross-linked material is resolved by polyacrylamide gel electrophoresis ("PAGE") and

exposed to X-ray film. The labeled complex containing the ligand-receptor can be excised, resolved into peptide fragments, and subjected to protein microsequencing. The amino acid sequence obtained from microsequencing can be used 5 to design unique or degenerate oligonucleotide probes to screen cDNA libraries to identify genes encoding the putative receptor molecule.

GSG polypeptides of the invention also can be used to assess binding capacity of GSG binding molecules, such as 10 receptor molecules, in cells or in cell-free preparations.

The invention also provides methods of screening compounds to identify those which enhance or block the action of GSGs on cells, such as its interaction with GSG-binding molecules such as receptor molecules. An agonist is a 15 compound which increases the natural biological functions of GSGs of the present invention or which functions in a manner similar to the GSGs, while antagonists decrease or eliminate such functions.

In one embodiment of an agonist/antagonist screening 20 assay, a cellular compartment, such as a membrane or a preparation thereof, such as a membrane-preparation, is prepared from a cell that expresses a molecule that binds a GSG of the present invention, such as a molecule of a signaling or regulatory pathway modulated by GSG. The 25 preparation is incubated with labeled GSG in the absence or the presence of a candidate molecule which may be a GSG agonist or antagonist. The ability of the candidate molecule to bind the binding molecule is reflected in decreased binding of the labeled ligand. Molecules that bind well and elicit 30 effects that are the same as or closely related to the GSGs are agonists. Molecules that bind well but do not elicit such effects are likely to be antagonists. GSG-like effects of potential agonists and antagonists may be measured, for instance, by determining activity of a second messenger system 35 following interaction of the candidate molecule with a cell

or appropriate cell preparation, and comparing the effect with that of GSGs or molecules that elicit the same effects as GSGs. Second messenger systems that may be useful in this regard include, but are not limited to, AMP guanylate cyclase, 5 ion channel or phosphoinositide hydrolysis second messenger systems.

Another example of an assay for GSG antagonists is a competitive assay that combines a GSG of the present invention and a potential antagonist with membrane-bound GSG receptor 10 molecules or recombinant GSG receptor molecules under appropriate conditions for a competitive inhibition assay. GSGs can be labeled, such as by radioactivity, such that the number of GSG molecules bound to a receptor molecule can be determined accurately to assess the effectiveness of the 15 potential antagonist.

Potential agonists include small organic molecules, peptides, polypeptides and antibodies that mimic binding of a GSG polypeptide to its receptor, thereby enhancing its activity. Potential agonists also include agents which 20 increase expression of GSGs.

Potential antagonists also may be small organic molecules, a peptide, a polypeptide such as a closely related protein or antibody that binds the same sites on a binding molecule, such as a receptor molecule, without inducing GSG- 25 induced activities, thereby preventing the action of GSGs by excluding GSGs from binding. Potential antagonists include small organic molecules, peptides, polypeptides and antibodies that bind to a polypeptide of the invention and thereby inhibit or extinguish its activity. Potential antagonists 30 also may be small organic molecules, a peptide, a polypeptide such as a closely related protein or antibody that binds the same sites on a binding molecule, such as a receptor molecule, without inducing GSG-induced activities, thereby preventing the action of GSGs by excluding GSGs from binding. Potential 35 antagonists include small molecules which bind to and occupy

the binding site of the GSG polypeptides thereby preventing binding to cellular binding molecules, such as receptor molecules, such that normal biological activity is prevented. Examples of small molecules include but are not limited to 5 small organic molecules, peptides or peptide-like molecules.

Other potential antagonists include antisense molecules. Antisense technology can be used to control gene expression through antisense DNA or RNA or through triple-helix formation. Antisense techniques are discussed, for example, 10 in Okano, J. Neurochem. 56: 560 (1991); OLIGODEOXYNUCLEOTIDES AS ANTISENSE INHIBITORS OF GENE EXPRESSION, CRC Press, Boca Raton, Fla. (1988). Triple helix formation is discussed in, for instance Lee et al., Nucleic Acids Research 6: 3073 15 (1979); Cooney et al., Science 241: 456 (1988); and Dervan et al., Science 251: 1360 (1991). The methods are based on binding of a polynucleotide to a complementary DNA or RNA. For example, the 5' coding portion of a polynucleotide that encodes the mature polypeptide of the present invention may be used to design an antisense RNA oligonucleotide of from 20 about 10 to 40 base pairs in length. A DNA oligonucleotide is designed to be complementary to a region of the gene involved in transcription thereby preventing transcription and the production of GSGs of the present invention. The antisense RNA oligonucleotide hybridizes to the mRNA *in vivo* and blocks 25 translation of the mRNA molecule into a GSG polypeptide. The oligonucleotides described above can also be delivered to cells such that the antisense RNA or DNA may be expressed *in vivo* to inhibit production of GSGs.

Compositions for Treatment of GSG related Diseases

30 It will be appreciated that conditions caused by a decrease in the standard or normal expression level of a GSG in an individual can be treated by administering a GSG of the present invention, preferably in the secreted form, or an agonist of GSG. Thus, the invention also provides a method 35 of treatment of an individual in need of an increased level

of the polypeptide comprising administering to such an individual a pharmaceutical composition comprising an amount of a GSG polypeptide or agonist to increase the activity level of the GSG polypeptide in such an individual.

5 Thus, the present invention also relates to compositions comprising a GSG polypeptide or agonist. These polypeptides or agonists may be employed in combination with a non-sterile or sterile carrier or carriers for use with cells, tissues or organisms, such as a pharmaceutical carrier
10 suitable for administration to a subject. Such compositions comprise, for instance, a media additive or a therapeutically effective amount of a polypeptide of the invention and a pharmaceutically acceptable carrier or excipient. Such carriers may include, but are not limited to, saline, buffered
15 saline, dextrose, water, glycerol, ethanol and combinations thereof. The formulation should suit the mode of administration.

Polypeptides and other compounds of the present invention may be employed alone or in conjunction with other
20 compounds, such as therapeutic compounds.

The pharmaceutical compositions may be administered in any effective, convenient manner including, for instance, administration by topical, oral, anal, vaginal, intravenous, intraperitoneal, intramuscular, subcutaneous, intranasal or
25 intradermal routes among others.

The pharmaceutical compositions generally are administered in an amount effective for treatment or prophylaxis of a specific indication or indications. In general, the compositions are administered in an amount of at
30 least about 10 $\mu\text{g}/\text{kg}$ body weight. In most cases they will be administered in an amount not in excess of about 8 $\mu\text{g}/\text{kg}$ body weight per day. Preferably, in most cases, dose is from about 10 $\mu\text{g}/\text{kg}$ to about 2 $\mu\text{g}/\text{kg}$ body weight, daily. It will be appreciated that optimum dosage will be determined by standard
35 methods for each treatment modality and indication, taking

into account the indication, its severity, route of administration, complicating conditions and the like.

The invention further relates to pharmaceutical packs and kits comprising one or more containers filled with one or 5 more of the polypeptides or other compounds of the present invention. Associated with such container(s) can be a notice in the form prescribed by a governmental agency regulating the manufacture, use or sale of pharmaceuticals or biological products, reflecting approval by the agency of the 10 manufacture, use or sale of the product for human administration.

Gene therapy

The GSG polynucleotides, polypeptides, agonists and antagonists that are polypeptides may be employed in 15 accordance with the present invention by expression of such polypeptides *in vivo*, in treatment modalities often referred to as "gene therapy." Thus, for example, cells from a patient may be engineered with a polynucleotide, such as a DNA or RNA, encoding a polypeptide *ex vivo*, and the engineered 20 cells then can be provided to a patient to be treated with the polypeptide. For example, cells may be engineered *ex vivo* by the use of a retroviral plasmid vector containing RNA encoding a polypeptide of the present invention. Such methods are well-known in the art and their use in the present invention will 25 be apparent from the teachings herein.

Similarly, cells may be engineered *in vivo* for expression of a polypeptide *in vivo* by procedures known in the art. For example, a polynucleotide of the invention may be engineered for expression in a replication defective 30 retroviral vector, as discussed above. The retroviral expression construct then may be isolated and introduced into a packaging cell transduced with a retroviral plasmid vector containing RNA encoding a polypeptide of the present invention such that the packaging cell now produces infectious viral 35 particles containing the gene of interest. These producer

cells may be administered to a patient for engineering cells *in vivo* and expression of the polypeptide *in vivo*. These and other methods for administering a polypeptide of the present invention by such method should be apparent to those skilled
5 in the art from the teachings of the present invention.

Retroviruses from which the retroviral plasmid vectors herein above mentioned may be derived include, but are not limited to, Moloney Murine Leukemia Virus, spleen necrosis virus, retroviruses such as Rous Sarcoma Virus, Harvey Sarcoma
10 Virus, avian leukosis virus, gibbon ape leukemia virus, human immunodeficiency virus, adenovirus, Myeloproliferative Sarcoma Virus, and mammary tumor virus. Such vectors will include one or more promoters for expressing the polypeptide. Suitable promoters which may be employed include, but are not limited
15 to, the retroviral LTR; the SV40 promoter; and the human cytomegalovirus (CMV) promoter described in Miller et al., Biotechniques 7: 980-990 (1989), or any other promoter (e.g., cellular promoters such as eukaryotic cellular promoters including, but not limited to, the histone, RNA polymerase
20 III, and .beta.-actin promoters). Other viral promoters which may be employed include, but are not limited to, adenovirus promoters, thymidine kinase (TK) promoters, and B19 parvovirus promoters. The selection of a suitable promoter will be apparent to those skilled in the art from the teachings
25 contained herein.

The nucleic acid sequence encoding a polypeptide of the present invention will be placed under the control of a suitable promoter. Suitable promoters which may be employed include, but are not limited to, adenoviral promoters, such
30 as the adenoviral major late promoter; or heterologous promoters, such as the cytomegalovirus (CMV) promoter; the respiratory syncytial virus (RSV) promoter; inducible promoters, such as the MMT promoter; the metallothionein promoter; heat shock promoters; the albumin promoter; the
35 ApoAI promoter; human globin promoters; viral thymidine kinase

promoters, such as the Herpes Simplex thymidine kinase promoter; retroviral LTRs (including the modified retroviral LTRs herein above described); the beta-actin promoter; and human growth hormone promoters. The promoter also may be the 5 native promoter which controls the gene encoding the polypeptide.

The retroviral plasmid vector is employed to transduce packaging cell lines to form producer cell lines. Examples of packaging cells which may be transfected include, but are not 10 limited to, the PE501, PA317, Y-2, Y-AM, PA12, T19-14X, VT-19-17-H2, YCRE, YCRIP, GP+E-86, GP+envAml2, and DAN cell lines as described in Miller, A., Human Gene Therapy 1: 5-14 (1990). The vector may be transduced into the packaging cells through any means known in the art. Such means include, but are not 15 limited to, electroporation, the use of liposomes, and CaPO₄ precipitation. In one alternative, the retroviral plasmid vector may be encapsulated into a liposome, or coupled to a lipid, and then administered to a host.

The producer cell line will generate infectious 20 retroviral vector particles, which include the nucleic acid sequence(s) encoding the polypeptides. Such retroviral vector particles then may be employed to transduce eukaryotic cells, either *in vitro* or *in vivo*. The transduced eukaryotic cells will express the nucleic acid sequence(s) encoding the 25 polypeptide. Eukaryotic cells which may be transduced include, but are not limited to, embryonic stem cells, embryonic carcinoma cells, as well as hematopoietic stem cells, hepatocytes, fibroblasts, myoblasts, keratinocytes, endothelial cells, and bronchial epithelial cells.

One method of gene therapy transplants fibroblasts, 30 which are capable of expressing a polypeptide, onto a patient. Generally, fibroblasts are obtained from a subject by skin biopsy. The resulting tissue is placed in tissue-culture medium and separated into small pieces. Small chunks of the 35 tissue are placed on a wet surface of a tissue culture flask,

approximately ten pieces are placed in each flask. The flask is turned upside down, closed tight and left at room temperature overnight. After 24 hours at room temperature, the flask is inverted so that the chunks of tissue remain fixed 5 to the bottom of the flask and fresh media (e. g., Ham's F12 media, with 10% FBS, penicillin and streptomycin) is added. The flasks are then incubated at 37°C for approximately one week. At this time, fresh media is added and subsequently changed every several days. After an additional two weeks in 10 culture, a monolayer of fibroblasts emerge. The monolayer is trypsinized and scaled into larger flasks. pMV-7 (Kirschmeier, P. T. et al., DNA, 7: 219-25 (1988)), flanked by the long terminal repeats of the Moloney murine sarcoma virus, is digested with EcoRI and HindIII and subsequently treated with 15 calf intestinal phosphatase. The linear vector is fractionated on agarose gel and purified, using glass beads.

The cDNA encoding a polypeptide of the present invention can be amplified using PCR primers which correspond to the 5'and 3'end sequences respectively. Preferably, the 5'primer 20 contains an EcoRI site and the 3'primer includes a HindIII site. Equal quantities of the Moloney murine sarcoma virus linear backbone and the amplified EcoRI and HindIII fragment are added together, in the presence of T4 DNA ligase. The resulting mixture is maintained under conditions appropriate 25 for ligation of the two fragments. The ligation mixture is then used to transform bacteria HB 101, which are then plated onto agar containing kanamycin for the purpose of confirming that the vector has the gene of interest properly inserted.

The amphotropic pA317 or GP+aml2 packaging cells are 30 grown in tissue culture to confluent density in Dulbecco's Modified Eagles Medium (DMEM) with 10% calf serum (CS), penicillin and streptomycin. The MSV vector containing the gene is then added to the media and the packaging cells transduced with the vector. The packaging cells now produce

infectious viral particles containing the gene (the packaging cells are now referred to as producer cells).

Fresh media is added to the transduced producer cells, and subsequently, the media is harvested from a 10 cm plate 5 of confluent producer cells. The spent media, containing the infectious viral particles, is filtered through a millipore filter to remove detached producer cells and this media is then used to infect fibroblast cells. Media is removed from a sub-confluent plate of fibroblasts and quickly replaced with 10 the media from the producer cells. This media is removed and replaced with fresh media.

If the titer of virus is high, then virtually all fibroblasts will be infected and no selection is required. If the titer is very low, then it is necessary to use a 15 retroviral vector that has a selectable marker, such as neo or his. Once the fibroblasts have been efficiently infected, the fibroblasts are analyzed to determine whether protein is produced.

The engineered fibroblasts are then transplanted onto 20 the host, either alone or after having been grown to confluence on cytodex 3 microcarrier beads.

Gene therapy methods can be used *in vivo* to treat disorders, diseases and conditions relating to underexpression 25 of a GSG of the present invention. The gene therapy method relates to the introduction of naked nucleic acid (DNA, RNA, and antisense DNA or RNA) sequences into an animal to increase or decrease the expression of the polypeptide.

The polynucleotide of the present invention may be operatively linked to a promoter or any other genetic elements 30 necessary for the expression of the polypeptide by the target tissue. Such gene therapy and delivery techniques and methods are known in the art, see, for example, WO 90/11092, WO 98/11779; U. S. Patent No. 5,693,622; 5,705,151; 5,580,859; Tabata H. et al. (1997) *Cardiovasc. Res.* 35 (3): 470-479, Chao 35 J et al. (1997) *Pharmacol. Res.* 35 (6): 517-522, Wolff J. A.

(1997) Neuromuscul. Disord. 7 (5): 314-318, Schwartz B. et al.
(1996) Gene Ther. 3 (5): 405-411, Tsurumi Y. et al. (1996)
Circulation 94 (12): 3281-3290 (incorporated herein by
reference).

5 The polynucleotide constructs may be delivered by any
method that delivers injectable materials to the cells of an
animal, such as, injection into the interstitial space of
tissues (heart, muscle, skin, lung, liver, intestine and the
like). The polynucleotide constructs can be delivered in a
10 pharmaceutically acceptable liquid or aqueous carrier.

The term "naked" polynucleotide, DNA or RNA, refers to
sequences that are free from any delivery vehicle that acts
to assist, promote, or facilitate entry into the cell,
including viral sequences, viral particles, liposome
15 formulations, lipofectin or precipitating agents and the like.
However, the polynucleotides of the present invention may also
be delivered in liposome formulations (such as those taught
in Felgner P. L. et al. (1995) Ann. NY Acad. Sci. 772: 126-139
and Abdallah B. et al.
20 (1995) Biol. Cell 85 (1): 1-7) which can be prepared by
methods well known to those skilled in the art.

The polynucleotide vector constructs used in the gene
therapy method are preferably constructs that will not
integrate into the host genome nor will they contain sequences
25 that allow for replication. Any strong promoter known to those
skilled in the art can be used for driving the expression of
DNA. Unlike other gene therapies techniques, one major
advantage of introducing naked nucleic acid sequences into
target cells is the transitory nature of the polynucleotide
30 synthesis in the cells. Studies have shown that non-
replicating DNA sequences can be introduced into cells to
provide production of the desired polypeptide for periods of
up to six months.

The polynucleotide construct can be delivered to the
35 interstitial space of tissues within an animal, including that

of muscle, skin, brain, lung, liver, spleen, bone marrow, thymus, heart, lymph, blood, bone, cartilage, pancreas, kidney, gall bladder, stomach, intestine, testis, ovary, uterus, rectum, nervous system, eye, gland, and connective tissue. Interstitial space of the tissues comprises the intercellular fluid, mucopolysaccharide matrix among the reticular fibers of organ tissues, elastic fibers in the walls of vessels or chambers, collagen fibers of fibrous tissues, or that same matrix within connective tissue ensheathing muscle cells or in the lacunae of bone. It is similarly the space occupied by the plasma of the circulation and the lymph fluid of the lymphatic channels. Delivery to the interstitial space of muscle tissue is preferred for the reasons discussed below. They may be conveniently delivered by injection into the tissues comprising these cells. They are preferably delivered to and expressed in persistent, non-dividing cells which are differentiated, although delivery and expression may be achieved in non-differentiated or less completely differentiated cells, such as, for example, stem cells of blood or skin fibroblasts. *In vivo* muscle cells are particularly competent in their ability to take up and express polynucleotides.

For the naked polynucleotide injection, an effective dosage amount of DNA or RNA will be in the range of from about 0.05 $\mu\text{g}/\text{kg}$ body weight to about 50 mg/kg body weight. Preferably the dosage will be from about 0.005 mg/kg to about 20 mg/kg and more preferably from about 0.05 mg/kg to about 5 mg/kg . Of course, as the artisan of ordinary skill will appreciate, this dosage will vary according to the tissue site of injection. The appropriate and effective dosage of nucleic acid sequence can readily be determined by those of ordinary skill in the art and may depend on the condition being treated and the route of administration. The preferred route of administration is by the parenteral route of injection into the interstitial space of tissues. However, other parenteral

routes may also be used, such as, inhalation of an aerosol formulation particularly for delivery to lungs or bronchial tissues, throat or mucous membranes of the nose. In addition, naked polynucleotide constructs can be delivered to arteries 5 during angioplasty by the catheter used in the procedure.

The dose response effects of injected polynucleotide in muscle *in vivo* is determined as follows. Suitable template DNA for production of mRNA coding for polypeptide of the present invention is prepared in accordance with a standard 10 recombinant DNA methodology. The template DNA, which may be either circular or linear, is either used as naked DNA or complexed with liposomes. The quadriceps muscles of mice are then injected with various amounts of the template DNA.

Five to six week old female and male Balb/C mice are 15 anesthetized by intraperitoneal injection with 0.3 ml of 2.5% Avertin. A 1.5 cm incision is made on the anterior thigh, and the quadriceps muscle is directly visualized. The template DNA is injected in 0.1 ml of carrier in a 1 cc syringe through a 27 gauge needle over one minute, approximately 0.5 cm from the 20 distal insertion site of the muscle into the knee and about 0.2 cm deep. A suture is placed over the injection site for future localization, and the skin is closed with stainless steel clips.

After an appropriate incubation time (e. g., 7 days) 25 muscle extracts are prepared by excising the entire quadriceps. Every fifth 15 um cross-section of the individual quadriceps muscles is histochemically stained for protein expression. A time course for protein expression may be done in a similar fashion except that quadriceps from different 30 mice are harvested at different times. Persistence of DNA in muscle following injection may be determined by Southern blot analysis after preparing total cellular DNA and HIRT supernatants from injected and control mice.

The results of the above experimentation in mice can be used to extrapolate proper dosages and other treatment parameters in humans and other animals using naked DNA.

5 **EXAMPLES**

The present invention is further described by the following examples. These examples are provided solely to illustrate the invention by reference to specific embodiments. These exemplifications, while illustrating certain aspects of 10 the invention, do not portray the limitations or circumscribe the scope of the disclosed invention.

All examples outlined here were carried out using standard techniques, which are well known and routine to those of skill in the art, except where otherwise described in 15 detail. Routine molecular biology techniques of the following example can be carried out as described in standard laboratory manuals, such as Sambrook et al., MOLECULAR CLONING: A LABORATORY MANUAL, 2nd Ed.; Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y. (1989).

20

Example 1: Relative Quantitation of Gene Expression

Real-Time quantitative PCR with fluorescent Taqman probes is a quantitation detection system utilizing the 5'-3' nuclease activity of Taq DNA polymerase. The method uses 25 an internal fluorescent oligonucleotide probe (Taqman) labeled with a 5' reporter dye and a downstream, 3' quencher dye. During PCR, the 5'-3' nuclease activity of Taq DNA polymerase releases the reporter, whose fluorescence can then be detected by the laser detector of the Model 7700 Sequence Detection 30 System (PE Applied Biosystems, Foster City, CA, USA).

Amplification of an endogenous control is used to standardize the amount of sample RNA added to the reaction and normalize for Reverse Transcriptase (RT) efficiency. Either cyclophilin, glyceraldehyde-3-phosphate dehydrogenase (GAPDH), 35 ATPsy6 (ATP synthase 6), or 18S ribosomal RNA (rRNA) is used

as this endogenous control. To calculate relative quantitation between all the samples studied, the target RNA levels for one sample were used as the basis for comparative results (calibrator). Quantitation relative to the 5 "calibrator" can be obtained using the standard curve method or the comparative method (User Bulletin #2: ABI PRISM 7700 Sequence Detection System).

The tissue distribution and the level of the target gene were evaluated for every sample in normal and cancer tissues. 10 Total RNA was extracted from normal tissues, cancer tissues, and from cancers and the corresponding matched adjacent tissues. Subsequently, first strand cDNA was prepared with reverse transcriptase and the polymerase chain reaction was done using primers and Tagman probes specific to each target 15 gene. The results were analyzed using the ABI PRISM 7700 Sequence Detector. The absolute numbers are relative levels of expression of the target gene in a particular tissue compared to the calibrator tissue.

20 **Expression of Cln114; Gene ID2385453 (human galectin-4):**

For the GSG Cln114, real-time quantitative PCR was performed using the following primers:

Forward Primer:

5'-AACCCGCCTGTGCCATATT-3' (SEQ ID NO:9)

25 Reverse Primer

5'-GGAGCCCACCTTGAAGTTGATA-3' (SEQ ID NO:10)

The absolute numbers depicted in Table 1 are relative levels of expression of the GSG referred to as Cln114 in 12 normal different tissues. All the values are compared to normal 30 uterus (calibrator). These RNA samples are commercially available pools, originated by pooling samples of a particular tissue from different individuals.

Table 1: Relative Levels of GSG Cln114 Expression in Pooled Samples

	TISSUE	NORMAL
5	Colon-Ascending	6562.4
	Endometrium	1.4
	Kidney	0.4
	Liver	3.9
	Ovary	9.5
10	Pancreas	9.6
	Prostate	1.0
	Small Intestine	213.8
	Spleen	4.5
	Stomach	59.3
15	Testis	1.7
	Uterus	1.0

The relative levels of expression in Table 1 show that Cln114 mRNA expression is more than 30 fold higher in the pool 20 of normal ascending colon (6562.4) compared with small intestine (213.8), and more than 110 fold higher than the expression in stomach (59.3). The other tissues tested show expression levels 650 fold lower than the levels in colon. These results demonstrate that Cln114 mRNA expression is 25 highly specific for gastrointestinal tissues including the colon, small intestine, and stomach.

The absolute numbers in Table 1 were obtained analyzing pools of samples of a particular tissue from different individuals. They can not be compared to the absolute numbers 30 originated from RNA obtained from tissue samples of a single individual in Table 2.

The absolute numbers depicted in Table 2 are relative levels of expression of Cln114 in 45 pairs of matching samples. All the values are compared to normal uterus

(calibrator). A matching pair is formed by mRNA from the cancer sample for a particular tissue and mRNA from the normal adjacent sample for that same tissue from the same individual.

Table 2: Relative Levels of GSG Cln114 Expression in Individual Samples

	SAMPLE ID	TISSUE	CANCER	MATCHING NORMAL ADJACENT
5	StoMT54	Stomach 1	290.4	201.6
10	SmI21XA	Small Intestine 1	842.4	379.8
15	ClnAS45	Colon-Ascending(A) 1	652.6	2215.3
20	ClnCM67	Colon-Cecum(B) 2	637.7	2072.3
25	ClnAS67	Colon-Ascending(B) 3	657.1	566.1
30	ClnAS12	Colon-Ascending(B) 4	503.4	4793.4
35	ClnAS43	Colon-Ascending(C) 5	9878.2	3108.8
	ClnAS46	Colon-Ascending(C) 6	5097.5	9543.6
	ClnAS89	Colon-Ascending(D) 7	491.1	129.8
	ClnAC19	Colon-Ascending(D) 8	1003.8	3694.2
	ClnTX01	Colon-Transverse(B) 9	723.1	2278.4
	ClnTX89	Colon-Transverse(B) 10	1337.2	464.6
	ClnTX67	Colon-Transverse(C) 11	989.1	1205.2
	ClnSG27	Colon-Sigmoid(C) 12	1738.1	2833.0
	ClnSG20	Colon-Sigmoid(B) 13	870.1	2370.0
	ClnSG45	Colon-Sigmoid(D) 14	754.8	1067.5
	ClnB34	Colon-Rectosigmoid(A) 15	562.2	664.0
	ClnCXGA	Colon-Rectum(A) 16	2486.7	3327.7
	ClnRC67	Colon-Rectum(B) 17	164.8	1132.3
	ClnC9XR	Colon-Rectosigmoid(D) 18	851.5	1883.4
	ClnRC01	Colon-Rectum(C) 19	1652.0	343.7
	ClnRC89	Colon-Rectum(D) 20	5.0	2556.6
	Bld32XK	Bladder 1	0.5	9.3
	Bld46XK	Bladder 2	0.5	0.8
	CvxKS83	Cervix 1	0.6	4.8
	CvxKS52	Cervix 2	1.5	2.4
	End12XA	Endometrium 1	0.5	7.3
	Kid11XD	Kidney 1	8.5	0.2
	Kid10XD	Kidney 2	14.4	1.7
	Kid107XD	Kidney 3	20.2	0.7
	Kid109XD	Kidney 4	849.3	4.9

	Kid106XD	Kidney 5	0.1	2.9
	Liv42X	Liver 1	270.0	5.0
	Liv15XA	Liver 2	41.7	14.4
	Liv94XA	Liver 3	19.3	2.0
5	Lng90X	Lung 1	1.5	1.2
	Lng60XL	Lung 2	1.6	1.8
	LngAC11	Lung 3	12.1	2.8
	Lng47XQ	Lung 4	0.5	2.0
10	Mam14DN	Mammary Gland 1	2.3	0.0
	Mam12X	Mammary Gland 2	0.0	0.0
	Pro12B	Prostate 1	2.1	0.2
	Tst39X	Testis 1	45.5	2.0
15	Utr85XU	Uterus 1	0.7	1.6
	Utr135XO	Uterus 2	0.5	0.2

15 0 = Negative

In the analysis of matching samples, the higher levels of expression were in colon, stomach, and small intestine, showing a high degree of tissue specificity. High levels of mRNA for Cln114 were seen in only one sample out of five matching samples for kidney (the cancer sample for the matching sample kidney #4 with a relative expression of 849.3). Also one sample out of three matching samples for liver (the cancer sample for the matching sample liver #1 with 270.0) showed high levels of mRNA for Cln114. These results 20 confirm the tissue specificity results obtained with the panel of normal pooled samples (Table 1).

Furthermore, the level of mRNA expression in cancer samples and the isogenic normal adjacent tissue from the same individual were compared. This comparison provides an 30 indication of specificity for the cancer stage (e.g. different levels of mRNA expression in the cancer sample compared to the normal adjacent). Table 2 shows lower expression of Cln114 in 15 colon cancer tissues (out of 20) compared with their respective normal adjacent (colon samples #1, 2, 4, 6, 8, 9, 35 11, 12, 13, 14, 15, 16, 17, 18, and 20). There was underexpression in the cancer tissue for 75% of the colon matching samples tested (15 out of 20 total colon matching

samples). The matching samples stomach #1 (sto MT54) and small intestine #1 (Sml 21XA) showed upregulation of mRNA for Cln114 in the cancer sample. After establishing a normal value for healthy individuals, lower levels of the product 5 encoded by the gene Cln114 could have diagnostic value for colon cancer, detecting close to 75% of the cases tested.

Altogether, the high level of tissue specificity, plus the lower mRNA expression in 75% of the colon matching samples tested are indicative of Cln114 being a diagnostic marker for 10 gastrointestinal cancer, specifically for stomach, small intestine, and colon cancer.

Expression of Gene ID 179792 (Cln115):

For the GSG Cln115, real-time quantitative PCR was 15 performed using the following primers:

Forward Primer

5'- GGCTGATGGTTGGCAGTTA-3' (SEQ ID NO:11)

Reverse Primer

5'- TTGTGAATGGGGCTCGTTT-3' (SEQ ID NO:12)

20 The absolute numbers depicted in Table 3 are relative levels of expression of the GSG Cln115 in 12 normal different tissues. All the values are compared to normal ovary (calibrator). These RNA samples are commercially available pools, originated by pooling samples of a particular tissue 25 from different individuals.

Table 3: Relative Levels of GSG Cln115 Expression in Pooled Samples

TISSUE	NORMAL
Colon-Ascending	1052.8
Endometrium	0.04
Kidney	0.1
Liver	0.03
Ovary	1.0

5

Pancreas	0
Prostate	0.1
Small Intestine	0.01
Spleen	1.6
Stomach	0.1
Testis	0.2
Uterus	0.2

10 The relative levels of expression in Table 3 show that Cln115 mRNA expression is more than 1000 fold higher in the pool of normal ascending colon (1052.8) compared to any other tissue tested. These results demonstrate that Cln115 mRNA expression is highly specific for colon.

15 The absolute numbers in Table 3 were obtained analyzing pools of samples of a particular tissue from different individuals. They can not be compared to the absolute numbers originated from RNA obtained from tissue samples of a single individual in Table 4.

20 The absolute numbers depicted in Table 4 are relative levels of expression of Cln115 in 51 pairs of matching samples. All the values are compared to normal ovary (calibrator). A matching pair is formed by mRNA from the cancer sample for a particular tissue and mRNA from the normal 25 adjacent sample for that same tissue from the same individual.

Table 4: Relative Levels of GSG Cln115 Expression in Individual Samples

30	SAMPLE ID	TISSUE	CANCER	MATCHING NORMAL ADJACENT
StoMT54	Stomach 1	0	0	
SMI21XA	Small Intestine 1	0	0	
ClnMT38	Colon-Splenic Flexture(M) 1	0	2613.50	
ClnAS45	Colon-Ascending(A) 2	368.10	2129.40	
ClnCM67	Colon-Cecum(B) 3	6.87	545.36	

	ClnB56	Colon-Cecum(C) 4	22.2	1089.90
	ClnAS67	Colon-Ascending(B) 5	0.3	147.0
	ClnAS12	Colon-Ascending(B) 6	55.59	1716.90
5	ClnAS43	Colon-Ascending(C) 7	3.10	388.40
	ClnAS46	Colon-Ascending(C) 8	5.30	4582.20
	ClnAS89	Colon-Ascending(D) 9	43.00	291.00
	ClnAS98	Colon-Ascending(C) 10	34.1	5461.10
	ClnAC19	Colon-Ascending(D) 11	2.80	835.75
10	ClnTX01	Colon-Transverse(B) 12	0.24	609.40
	ClnTX89	Colon-Transverse(B) 13	1.7	127.60
	ClnTX67	Colon-Transverse(C) 14	0.20	499.7
	ClnDC63	Colon-Descending(C) 15	53.50	1873.40
	ClnSG67	Colon-Sigmoid(C) 16	2.52	13.95
15	ClnSG20	Colon-Sigmoid(B) 17	0.30	3381.54
	ClnSG45	Colon-Sigmoid(D) 18	6.70	1494.0
	ClnSG89	Colon-Sigmoid(B) 19	27.4	1441.40
	ClnSG36	Colon-Sigmoid(B) 20	2.7	4577.14
	ClnSG33	Colon-Sigmoid(C) 21	64.5	1320.98
20	ClnSG20	Colon-Sigmoid(B) 22	0.3	3381.54
	ClnSG27	Colon-Sigmoid(B) 23	77.7	2739.50
	ClnSG66	Colon-Sigmoid(C) 24	0.1	1222.66
	ClnRC24	Colon-Rectum(D) 25	2292.2	3972.90
	ClnRC01	Colon-Rectum(C) 26	2267.9	33.08
	ClnCXGA	Colon-Rectum(A) 27	1.10	1991.42
25	ClnRC67	Colon-Rectum(B) 28	25.10	626.00
	ClnSG98	Colon-Rectosigmoid(C) 29	42.46	1884.52
	ClnRS45	Colon-Rectosigmoid(C) 30	689.80	1567.79
	ClnRS16	Colon-Rectosigmoid(B) 31	286.51	1049.25
	ClnRS53	Colon-Rectosigmoid(C) 32	9.42	2529.61
30	ClnB34	Colon-Rectosigmoid(A) 33	1.20	394.80
	ClnC9XR	Colon-Rectosigmoid(C) 34	6.30	2741.70
	ClnDC19	Colon-Descending(B) 35	351.50	1197.10
	ClnDC22	Colon-Descending(D) 36	19.30	2576.20
	ClnRC01	Colon-Rectum(C) 37	1351.2	116.2
35	ClnRC89	Colon-Rectum(D) 38	0.40	1024.0
	Bld32XK	Bladder 1	0.12	0.54
	CvxKS52	Cervix 1	4.33	7.91
	End10479	Endometrium 1	0	0
40	Kid107XD	Kidney 1	0.84	9.62
	Kid109XD	Kidney 2	0	1.42
	Kid106XD	Kidney 3	0.28	0

Liv15XA	Liver 1	1.00	0.41
Lng47XQ	Lung 1	0	0
Mam12X	Mammary Gland 1	0	0
Tst39X	Testis 1	0	0
Utr85XU	Uterus 1	0	0

5 0 = Negative

In the analysis of matching samples, the higher levels of expression were in colon. These results confirm the tissue 10 specificity results obtained with normal pooled samples (Table 3).

Furthermore, the level of mRNA expression in cancer samples and the isogenic normal adjacent tissue from the same individual were compared. This comparison provides an 15 indication of specificity for the cancer stage (e.g. lower levels of mRNA expression in the cancer sample compared to the normal adjacent). Table 4 shows lower expression of Cln115 in 36 colon cancer tissues compared with their respective normal adjacent out of a total of 38 matching samples tested. 20 Thus, there is lower expression in the cancer tissue for 94.7% of the colon matching samples tested (total of 38 colon matching samples). The only cancer samples that showed overexpression of Cln115 were colon#26 and #37. After establishing a normal value for healthy individuals, lower 25 levels of the product encoded by the gene Cln115 could have diagnostic value to determine the presence of colon cancer, detecting close to 94% of the cases tested.

Altogether, the high level of tissue specificity, plus the mRNA differential expression in the matching samples 30 tested are indicative of Cln115 being a diagnostic marker for gastrointestinal cancer, and in particular colon cancer.

Example 2: Expression of Cln114 in *E. coli*

Cln114 was amplified by polymerase chain reaction (PCR) 35 using colon cDNA libraries and Cln specific primers. The amplified DNA fragment encoding amino acid number 1 (Met¹) to

amino acid number 323 (Ile³²³) of Cln114 was subcloned in a T7 RNA polymerase-based system (pET-21d) for expression in *E. coli*. In addition to Cln114 DNA coding sequence (Met¹-Ile³²³), codons for six histidines, flanking the COOH-terminus of 5 Cln114, were incorporated to use as purification tag.

Cln114 Construct: Met¹-Ile³²³(His)₆

NH₂/MAYVPAPGYQPTYNPTLFFYQQPIPGGLNVGMSVYIQGVASEHMKRFFVNFFVVGQDPGSDVAFHFNPREFDGWDKVVFNTLQGGKGSEERKRSMPFKKAAFEVLFIVIAEHYKVVVNGNPFYEGHRLPLQMVTQLQVD10 GDLQLQSINFIGGQPLRPQGPMMPPYPPGPGHCHQQQLNSLPTMEGPPTFNPPVPPYFGRLLQGLTARRTIIKGYVPTGKSPAINFKVGSSGDIALHINPRMGNTVVRNSLLNGSGWGESEEKKITHNPFCPGQFEDLSIRCG15 LDRFKVYANGQHLFDFAHRLSAFQRVDTLEIQGDVTLSYVQIHHHHHHH/COOH (SEQ ID NO:13)

A high level of Cln114 expression was observed when the 15 plasmid construct was transformed in *E. coli* host BL21-CODONPLUS(DE3). An over-expressed protein band of approximately 36 kDa was readily observed on a Coomassie blue stained polyacrylamide gel. Positive result from Western blot analysis using monoclonal antibody against 6 x Histidine tag 20 confirmed the expression of Cln114.